International Journal of Applied Social Science
Volume 6 (11&12), November & December (2019) : 2385-2390
Received : 23.10.2019; Revised : 08.11.2019; Accepted : 23.11.2019

RESEARCH PAPER
ISSN : 2394-1405
DOI: 10.36537/IJASS/6.11&12/2385-2390

Identification and Construction of Flood Disaster Resilience Index to Measure Socio-Economic Flood Resilience in Eastern Uttar Pradesh: A Inter-District Analysis

NOOPUR MISHRA*[1] AND SUBHKANTA MOHAPATRA[2]
Department of Geography, School of Sciences
Indira Gandhi National Open University (IGNOU), Delhi (India)

ABSTRACT

Globally, floods are viewed as the most destructive of all naturally triggered disasters. More than 15 Countries which accounts 80% of population expose to flood disaster are in Asia according to UNESCAP. In today's scenario we can say that there are many major causes that makes it more vulnerable for current society in India i.e. encroachment of land and water resources, Urbanization, hike in population unmet demands, global warming that resulting into climate change, Poor infrastructural and institutional remedies for disaster, lack of inclusive and grounded policies are converting this natural hazard into most disastrous events. In other words we can say that anthropogenic hazards are accelerating the influence of such natural fury. Hydrological disasters still took the largest share in natural disaster occurrence in 2015: 46.5% to compare; however, to a proportion of 50.6%, on average, for the years 2005-2014. In India the most populous states like U.P. and Bihar where nearly 2/3 of population is dependent on agriculture suffers a lot because of these disastrous event. Tributaries of river Ganga maroons livelihood of so many people almost each or alternate years. This paper aimed to study the flood disaster resilience through Composite index that allow us to understand and identify the resilience capacity in Eastern U.P. Secondary data is used for this study and indicators are proxy indicators that comprises 5 parameters physical, social, Economic, Infrastructural, Community capacity. Districts are selected on the basis of flood affected areas and other districts are eliminated for this study. The result shows that districts have higher index value are more capable to cope with the disaster. This paper also sees the highly impactful parameter and co relation between them. Least resilient districts need to improve mechanism to be more resilience.

Key Words : Floods, Disaster, Flood resilience, Socio-economic, Composite index

INTRODUCTION

Floods are the one of most triggered natural disaster that their frequency of occurrence or their damage capacity varies over the period of time. Recent scenario of flood disaster is not very much appreciable globally. The data depicts their return period not just only increased but the damage is also severely extended. Floods in India also vary in terms of occurrence, frequency and intensity from coastal floods to flash floods and from hilly regions to plains. Hence, Measures of mitigation also varies for different flood types. Similarly the risk and Resilience also differ in the context of different states. States like Orissa has develop the mechanism to reduce the risk of cyclone induced floods and disaster But We are not somehow able to manage their impact in holistic manner specifically in the northern Indian states like Bihar, Eastern U.P. some part of Madhya Pradesh. Major reasons are Lack of institution, unavailability of Systematic and synchronized training and disaster management Centre's in the states making these regions more vulnerable towards different disasters.

Floods are very crucial and destructive events. Varied physiography and climatic variability can leads to

How to cite this Article: Mishra, Noopur and Mohapatra, Subhkanta (2019). Identification and Construction of Flood Disaster Resilience Index to Measure Socio-Economic Flood Resilience in Eastern Uttar Pradesh: A Inter-District Analysis. *Internat. J. Appl. Soc. Sci.,* **6** (11&12) : 2385-2390.

differences between occurrence pattern and its impact over region. The Eastern U.P. is one of the under develop region of the country that remain affected by flood hazard that leads to the loss of cultural, social, and political assets of State .The Floods of 2007 that affected 1.2 million people mostly in 22 districts of Eastern Uttar Pradesh in late July. It affected more than 2,546 villages out of which about 1350 villages were marooned. Approximately about 60,000 children below the age of 5 years were reported to be affected. Most affected districts in terms of severity were Bahraich, Gorakhpur, Maharajganj, Barabanki, Gonda, Shravasti, Balrampur, Basti and Azamgarh and Kushinagar. This paper is an attempt to present a comprehensive study about the flood resilience in Eastern Uttar Pradesh with the help of development of flood resilience composite index through socio – economic parameters and to analyze and assess socio - economic impact of flood in this region and explain major constrains and problems in flood mitigation

Defining the term Resilience:

Term "resilience" was coined by C.S. Holling in his landmark 1973 paper on systems ecology. It stems from resilire, resilio, Latin word for "bounce" – so the idea of "bouncing back Resilience is term that got its origin from Resilience, the ability to bounce back or cope successfully despite substantial adversity (Rutter, 1985). It is measured as the capacity of a system to return back to previous condition in terms of social, economic or community capacity or infrastructural or so on.

There are many terms that are associated with resilience. *i.e.* Coping, Recovery, adaptation but none of these terms actually suits to the purpose or seen as fulfill the desired meaning. Hence the term resilience fulfills the purpose and incorporates these all terms precisely.

Hence, Resilience represents the capacity of a system or community exposed to any hazard to adapt by resisting or changing in order to reach an acceptable level of functioning, organization and structure.

Socio - economic Resilience to floods:

Socio economic parameters for any study indicates that there is the involvement of human who is generator and receiver both. Human has the social behaviours like culture, caste and creed, languages, education, health facility that has been created and survived by human himself. Where as economic amenities like per capita income, infrastructure, banking facility, production all are produced by him for himself. Hence, when a disaster took place it is very important to see the root of socio-economic characteristics within the regional variability. This is very important to associate the regional variability and socio economic association within them.flood do have originity by natural phenonmena but the narural process impact should be discussed and understand from the glance of socio-Economic perspective. Work of Cutter, *et al.* (2010), focuses on resilience indicators and provides a set of indicators for measuring baseline characteristics of communities that foster resilience. Cutter's list of disaster resilience indicators contains thirty-six variables from within the categories of social resilience, economic resilience, institutional resilience, infrastructural resilience and community capital. Similarly, Balica *et al.* (2012) has extensively worked on vulnerability assessment in in 9 most important coastal cities from Kolkata to manila and Rotterdam and tried to assess the vulnerability through index method. Llyod and Perfrement (2016) has presented the development of a composite flooding disaster resilience index (FDRI) by aggregating individual resilience indicators under the social, natural, built and economic categories.Here, the socio economic characteristics have been used to measure the resiliency from floods in the region.

Study Area:

Eastern (Purvanchal) Uttar Pradesh is extending between 23° 51' N to 28° 31' N latitudes and 81 °30' E to 84 ° 39' E longitudes, covering an area of 85298.79 km^2 (29.10 % of the state). Eastern Uttar Pradesh consists of 27 district, 117 tehsil, and 341 community development blocks. Eastern Uttar Pradesh lies in the northern sub-continental interior of the sub-tropical climate belt, the monsoon with all its rhythms, vagaries and extremes reigns supreme and affected intricately almost every detail of the occupancies and life pattern of the people.

Components of Disaster Resilience :

Flood resilience in Eastern U.P. will measure by collecting the data on different parameters and indicators. There are five parameters have been selected to assess flood resilience according to area flooded in eastern U.P. (Irrigation and water resource department (U.P.) (2016). Hence, 20 districts have been selected for measuring the flood resilience in eastern U.P. Natural resilience, Social resilience, Economic resilience, Infrastructural

resilience and community resilience .There are 19 proxy indicator selected to pilot the flood resilience composite index for Eastern Uttar Pradesh (Table 1.)

Natural Resilience:

Under natural resilience three major proxy indicators have been selected to measure the flood resilience in Eastern UP. Area affected by flood in hectares. Second is elevation from mean sea level. Third is rainfall in cm.

Social Resilience:

Under social resilience indicators five proxy indicators selected. Population density, % working group population, % of literates, % of disabled population, % of urban population to total population.

Economic Resilience:

Under economic resilience indicator total four indicators been selected, Per Capita Net Income in district, Total % of household availing banking Facility. % of population have APL ration card.

Infrastructural Resilience:

Under infrastructural 5 indicators has been selected Total health service Centre's on per lakh population, Total no. of routes of roads, Total surface roads on per lakh population, Total no. of schools in district. Distance from state capital (Lucknow).

Community Capacity:

Under community capacity objective was to measure the community resilience so here 2 indicators have been selected No. of people are graduated and above And % of people have mobile phones

METHODOLOGY

This paper is for the fulfillment of objective of my

Table 1 : Components of disaster resilience index

Parameter (Indicators category)	Indicators	Effect (Relation)	Value	Data source
Natural Resilience	1) Total area affected by flood	Negative	No.	Irrigation and water resource department U.P. Central water commission (CWC)
	2) Elevation (height above or below to MSL)	Positive	No	Survey of India
	3) Rainfall (in cm)% of rainfall during monsoon	Negative	Percentage	Indian Meteorological Department, (IMD) Irrigation and Water resource Department (2016)
Social Resilience	4) Population density	Negative	Percentage	Census of India (2011)
	5) Age group (% of total working population composition)	Positive	Percentage	Census of India (2011)
	6) Percentage of disabled population	Negative	Percentage	Census of India (2011)
	7) Percentage of Urban population to Total Population	Positive	Percentage	Census of India (2011)
	8) Education (% of literate people)	Positive	Percentage	Census of India (2011)
	9) % of Main Workers to total Population	Positive	Percentage	Census of India (2011)
Economic Resilience	10) Wealth(Per Capita net household income)	Positive	No.	Statistical Diary 2015
	11) Total % of household availing Banking Services	Positive	Percentage	DCHS, 2011
	12) No. of household have APL Ration Card	Positive	Percentage	Statistical Diary 2015
Infrastructural Resilence	13)Total No. of schools on per Lakh Population	positive	Percentage	Census of India 2011
	14) No. of Roadways routes by that district is connected	Positive	No	UPPWD (2017)
	15) Length of surface Roads in (Kms) per lakh Population	Positive	No.	UPDES (016), data.gov.in
	16) Distance from Capital of States	Positive	No.	Statistical Diary ,2015
	17). No. of Health Care Centre on per lakh population	Positive	No.	Census of India (2011)
Community Capacity	18) % of people are Graduated and above population to Total Population	Positive	Percentage	Census of India 2011
	19) % of household have Mobile Phones	Positive	Percentage	Census of India, 2011

study that is flood resilience. Where conceptual framework done through different literature and seminal research work, different Books ,articles research paper, governmental and nongovernmental reports have been used to build up comprehensive idea about topic. As this work Based on quantitative analysis hence, statistical tools have been used to computing and processing of the data that shown through Charts, tables and maps.

The present work is been done on HDI method, Whereas, The Human Development Index (HDI) is a composite statistic (composite index) of life expectancy, education, and per capita income indicators, which are used to rank countries into four tiers of human development. The HDI was developed by Pakistani economist Mahbubul Haq for the UNDP.

The formula defining the HDI is promulgated by the United Nations Development Programme (UNDP). x, into a unit-free index between 0 and 1 (which allows different indices to be added together), the following formula is used

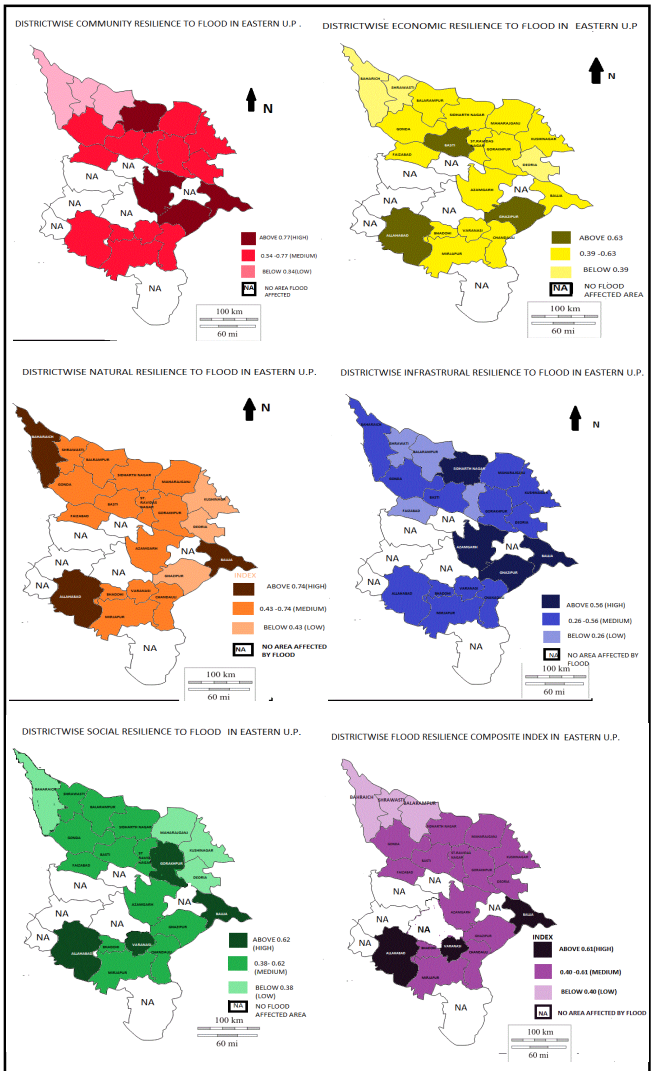
$$HDI = \frac{(x - a)}{(b - a)}$$

Where, (x)is actual value of factor, (a), is minimum value, (b) is maximum value

$$\text{Composite index} = \frac{\Sigma x}{\Sigma n}$$

where Σx is total of indicators value and Σn is total no. of indicators

Standard score range has been calculated and categorization of districts have been done under High, medium and low. Then, table and chart has been made to show and analyze the variation in the result. Next map has been prepared for the study area to show district wise variation in flood resilience.



Source: Based on Secondary Data Analysis

Fig. 1 : Map from left to Right showing: 1) Community Resilience 2) Economic Resilience 3) Natural Resilience 4) Infrastructural Resilience 5) social Resilience 6) Composite flood Resilience

RESULTS AND DISCUSSION

Findings show that how district wise flood resilience is varying and the composite index for flood disaster resilience (Map 6). Result of flood resilience is not based on single parameter. Hence, it is giving a multifaceted view about the geographical expression and human expression both. We can see that Varanasi Allahabad and Ballia have high resilience score; Whereas Shrawasti, Bahraich and Balarampur are showing low Resilience.

Table 2 : Composite flood resilience index value

Composite flood resilience index value	Resilience category	Districts
Below 0.39	Low	Shrawasti, Bahraich Balarampur
0.39 - 0.59	Medium	Sant Kabirnagar, Maharajganj, Gonda Kushinagar, Deoaria, Sidharth Nagar, Sant Ravidas Nagar (bhadohi), Basti, Chandauli, Faizabad, Mirzapur Ghazipur, Azamgarh, Gorakhpur
Above 0.59	High	Varanasi, Ballia, Allahabad

Total 14 districts have medium resilience to flood activity. Here the major reason for difference is poor infrastructure, poor socio economic condition and poor community capacity. But When we see Allahabad have highest value in economic resilience, social resilience and Varanasi and Ballia that falling in highly resilient major factor that are influencing here is Varanasi almost have highest social (0.72) and community capacity(0.85) that making this district highly resilient.

Ballia has second rank in overall resilience. Ballia have social (0.65), Natural (0.88), infrastructure (0.63) that making district highly resilient to flood. Allahabad has obtained highest economic (0.70), social (0.65) value and ranked under 5 in all parameter of resilience. Parameters like social, Economic and Infrastructural have played a significant role in allotting the districts higher or lower resilience value (Table 3).

Community capacity (Map 1) in districts when we see Gorakhpur, Ballia and Varanasi has secured highest value, Where as Shrawasti, Bahraich, and Balarampur has lower community capacity, as community capacity is seen in the context of people who are graduated and above in that category Gorakhpur high resilience obtained on the basis of % of household have mobile phones and people graduated and above. Reason for higher Percentage of graduated is because cities like Varanasi and Allahabad have the universities that leads to migration of students from these adjoining districts for better education facility.

Economic resilience (Map 2) we found that district like Basti, Ghazipur Allahabad has obtained high economic resilience Reason, Here is Number of people availing banking facility is very high in whereas percentage of main working population is also very high. Baharaich, Shrawasti and Deoria has vested poor economic resilience.

Natural resilience (Map 3) the highest score is obtained by Allahabad, Bahraich and Ballia. Under natural resilience 3 indicators have been selected rainfall in mm, Area affected by flood and elevation from mean sea level.

Under infrastructure Resilience (Map 4) total 4 district has come under high resilience that is because the no. of schools per lakh population is high, No. of connecting routes are more and No. of hospitals per lakh population is also very high.

Social resilience Map 5) index we have seen that 4 districts are falling in high resilience category and 4 districts are also falling in the category of low resilience

Table 3 : Parameter wise flood disaster resilience index

District	Social resilience	Rank	Natural resilience	Rank	Economic resilience		Infrastructure	Rank	Community capacity	Rank	Composite value	
Allahabad	0. 65	3	0.75	3	0.70	1	055	5	0.73	5	0.69	1
Azamgarh	0.50	10	0.67	7	0.49	11	0.60	4	0.68	6	0.56	5
Bahraich	0.37	17	0.75	2	0.25	20	0.31	15	0.09	19	0.36	19
Balarampur	0.31	19	0.62	9	0.59	6	0.21	18	0.28	18	0.38	18
Ballia	0.65	2	0.88	1	0.56	8	0.63	1	0.82	2	0.68	2
Basti	0.48	13	0.51	15	0.66	3	0.38	12	0.62	9	0.5	10
Chandauli	0.59	6	0.61	10	0.45	13	0.38	11	0.55	12	0.52	9
Deoria	0.54	8	0.39	18	0.37	18	0.45	10	0.76	4	0.48	13
Faizabad	0.56	7	0.73	4	0.62	5	0.21	19	0.58	11	0.53	7
Ghazipur	0.49	11	0.28	20	0.70	2	0.60	3	0.63	8	0.55	6
Gonda	0.43	16	0.72	5	0.62	4	0.29	16	0.42	17	0.47	15
Gorakhpur	0.63	4	0.54	13	0.44	15	0.48	7	0.77	3	0.58	4
Kushinagar	0.52	9	0.37	19	0.43	17	0.54	6	0.54	13	0.48	13
Maharajganj	0.48	14	0.43	17	0.43	16	0.45	9	0.47	15	0.45	16
Mirzapur	0.59	5	0.61	11	0.58	7	0.45	8	0.46	16	0.53	7
Sant Kabir Nagar	0.44	15	0.52	14	0.45	14	0.36	13	0.59	10	0.44	17
Sant Ravidas Nagar (Bhadohi)	0.48	12	0.70	6	0.54	9	0.22	17	0.54	14	0.49	11
Shrawasti	0.26	20	0.56	12	0.36	19	0.11	20	0.08	20	0.25	20
Sidharth Nagar	0.35	18	0.44	16	0.53	10	0.61	2	0.64	7	0.49	11
Varanasi	0.72	1	0.63	8	0.49	12	0.36	14	0.85	1	0.64	3

whereas 12 districts are falling into medium category of flood resilience. Negative indicators like density of population and disabled population other indicators have been seen as major influencer of social resilience. Social resilience is determined by urban population Percentage, Percentage of literates and Percentage of working age group population. That is higher in the Centre's like Allahabad and Varanasi.

Conclusion:

Flood resilience in Eastern U.P. in selected districts is seen as those districts which are highly resilient that is because of improved social, economic conditions. These conditions have played very important role to building these districts more resilient or less resilient. The result also revealed that these factors are not alone making these districts high resilient or less resilience. They are showing coherence that how social parameter is associated with economic parameter and getting influenced by natural parameter.

In nutshell, Flood resilience is about how prepare we are for flood disaster and measuring that can be an important aspect for the purpose of disaster risk reduction and mitigation. They are also showing coherence that how social parameter is associated with economic parameter and getting influenced by natural parameter.

This study is as based on secondary data. Hence, reliability is more on these data that has been given by institution like disaster management authority and other demographic data that somehow need to be verifying with primary data. Data given by state disaster management authority is also not very satisfactory for the detailed study on this theme. Urban Centre's like Allahabad, Varanasi have showed higher resilience because of good infrastructural and economic characteristics that also have to measure through other lenses where the problem of urban flooding can be looked thoroughly.

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